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13. ABSTRACT (Maximum 200 words) Our earlier studies of molecule-surface CID were extended to the case of NO <sub>2</sub> , which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited NO <sub>2</sub> . Because the NO <sub>2</sub> zeroth order 2B <sub>2</sub> excited state is strongly coupled to the 2A <sub>1</sub> ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely, NO <sub>2</sub> entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal plus translational energy to undergo CID, which was observed for a range of NO <sub>2</sub> internal excitations. Unexcited NO <sub>2</sub> yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that NO <sub>2</sub> decomposes rapidly following impact with the surface, in accord with k(E) measurements that indicate subpicosecond lifetimes for excess energies ~ 500 cm <sup>-1</sup> . This was the first demonstration of such an effect and supports the thesis that NO <sub>2</sub> is responsible for the shuttle glow.				
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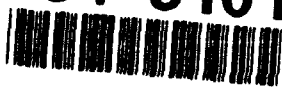
**GAS-SURFACE INTERACTIONS NEAR  
DISSOCIATION THRESHOLD**

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### Technical Report:

Our earlier studies of molecule-surface CID were extended to the case of  $\text{NO}_2$ , which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited  $\text{NO}_2$ . Because the  $\text{NO}_2$  zeroth order  $^2\text{B}_2$  excited state is strongly coupled to the  $^2\text{A}_1$  ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely,  $\text{NO}_2$  entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal *plus* translational energy to undergo CID, which was observed for a range of  $\text{NO}_2$  internal excitations. Unexcited  $\text{NO}_2$  yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that  $\text{NO}_2$  decomposes rapidly following impact with the surface, in accord with  $k(E)$  measurements that indicate subpicosecond lifetimes for excess energies  $> 500 \text{ cm}^{-1}$ . This was the first demonstration of such an effect and supports the thesis that  $\text{NO}_2$  is responsible for the shuttle glow.

In addition, recent FTIR spectroscopy of ClNO adsorbed on  $\text{MgO}(100)$ , suggest that ClNO aggregates on the surface in a way that affects photon-induced processes.

The progress of the students, James Brandon and James Singleton, in their course-work as well as other requirements of the Ph.D. program is satisfactory.

### Evaluation Report

The parent award number to which the AASERT students are linked is P49620-92-J-0168. The amount of funding of the parent award for the period 12/01/93 - 11/30/94 is \$175,000 and one (1) graduate student was supported under the said award prior to and after the AASERT award. The amount of funding under the AASERT program for the period 05/01/92 - 04/30/95 is \$94,091 (\$31,364 per year) and two (2) graduate students (above-mentioned names) were partially supported under this award for the period 05/01/93 - 04/30/94.

This is to certify that James Brandon and James Singleton are United States citizens. Verification was made through presentation of their birth certificates stating their birthdates and birthplaces, as well as their social security numbers.

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